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ABSTRACT

This paper is one in a series of studies which highlight and synthesize recent research and practice in educational management. The paper presented here discusses recent research findings and current practice on the adoption, implementation, and integration of microcomputers into the instructional program at the elementary and secondary levels. The first part draws upon a recent two-year study that examined the empirical information derived since 1980 on the adoption, implementation, and integration of microcomputers within the elementary and secondary instructional program in the United States. The research findings are organized around six contextual divisions identified in the study: setting, resources, governance, implementation, process evaluation, and integration. The subsequent section discusses general implications for action, focusing on two primary areas of responsibility: (1) incorporating computer literacy as an integral part of the curriculum at all instructional levels and (2) exploiting the potential of this technology for improving instructional methodology. The correlates of educational policymaking relative to microcomputer adoption focus on three types of reinvention: operational, technical, and managerial. The final section is a case study of Sacramento City Unified School District's strategic plan entitled "Opportunity 21: A Guide to the Twenty-First Century." This strategy incorporates planning and feedback processes that are critical to the full integration of educational technology into the schools. The 12 most important ideas to emerge from the research are summarized, and a bibliography is included. (TE)

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TRENDS & ISSUES

A series of papers highlighting recent developments in research and practice in educational management

Change in Public Education: A Technological Perspective

by Thomas V. Gillman

U.S. DEPARTMENT OF EDUCATION
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Foreword

The ERIC Clearinghouse on Educational Management is pleased to publish this initial volume in the Trends and Issues Series. This paper, by Thomas V. Gillman, synthesizes recent research findings and current practice on educational change, specifically from the perspective of the adoption, implementation, and integration of microcomputers into the instructional program at the elementary and secondary levels. Advocating an open system perspective on organizational change, Gillman encourages educational leaders and policy-makers to adopt such a perspective as a step toward bringing about structural reform of public education.

The research for this paper is based on Gillman's doctoral dissertation, "Adoption, Implementation, and Integration of Instructional Microcomputing (K-12): A Synthesis of Findings."

Gillman holds a bachelor's degree from Princeton University, master's degrees from the University of Colorado and Hofstra University, and a doctor's degree in educational policy and management from the University of Oregon. He has served as a teacher and school district administrator in New York State and is now active as a management consultant in organizational development and strategic planning. Gillman is currently president of Transformation Leadership Systems in Eugene, Oregon.

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Introduction

This paper provides an analysis of the growing impetus for change in public elementary and secondary education. The initial perspective is one gained during the current decade in attempts to improve education through the adoption of microcomputer technology. This analysis also brings into relief some of the broader issues involved in educational development, since it has become clear that the impediments to change are not delimited to technological innovation but are representative of general structural deficiencies within the educational system. Some suggestions are made for constructive strategies that might help remedy the situation. Finally, a case study is presented that shows the power of strategic planning and gives promise that, with the help of educational technology, public education can once again be an integrative force as we enter the information age.

The Recent Past

While attempts have been continuously made to improve public education, most of them have been made within the bounds of existing organizational structure. The accountability movement, teaching by objectives, formative and summative evaluation, criterion-referenced testing—all were conceived as means for planning and better controlling the effectiveness of the teaching-learning process. Educational technology has been conscripted to aid in the process. Resource centers and learning labs have been established. But despite the time and energy that have been devoted to these tasks, the impact nationally has been dismal.

There is hope, however. The entire American economy has been undergoing a metamorphosis as this country grows out of an industrial era into an age of communication in which information services, research, planning, and technical know-how are becoming paramount. Over the next decade, the country's growing entrepreneurial economy is likely to produce a surplus of challenging jobs. A global economy is also developing in which there are exciting careers. The present cycle of wars, poverty, underemployment, welfare, and crime could be broken. Education is the key to this future.

Organizational survival depends on the ability to adapt to changing demands. Many new organizations are coming into existence as entrepreneurs recognize the possibilities for new markets. Perhaps for the first time, simultaneous efforts at organizational development across many fields are enabling researchers, theorists, and working administrators to key in on the impediments to change that are common to all organizations. In conjunction with those efforts, the current attempt to integrate the microcomputer innovation into the instructional program of the schools is providing a vital opportunity to examine many of the impediments to change that are unique to the field of education itself.

Time for Action

Workers and professionals in all occupations can no longer succeed with rudimentary literacy or the accumulation of specialized facts. They will need to learn throughout their lives. And youth from every level of society will need to receive an education that enables them to participate fully in the active society of the twenty-first century. It is apparent that the time is at hand for bold and concerted action to allow public education to regain its position as a viable, integrative institution of society. Success will depend on the problem-solving ability, creativity, and cooperation of all segments of society, but leadership and initiative will be paramount.

This paper will first examine the most recent and ongoing attempt to improve educational effectiveness through the promotion of technological innovation, specifically instructional microcomputing. Since the beginning of the decade, microcomputer technology has been undergoing continuous development, leading to its widespread acceptance and use in most sectors of business, industry, and research. Similar expectations were held for use of the technology in instruction, but there is considerable disappointment to date about the extent to which the increasing potential of this innovation has been exploited within educational circles.

Organizational scholars have amply detailed ways in which bureaucratic structure can resist change because of emphasis on hierarchical levels, role relationships, standardized procedures, control from the top, values of disciplined compliance, and so forth. Similarly, directing the numerous social systems of an educational organization into a collaborative effort is complex because the various subsystems often have their own informal goals, power bases, and norms governing behavior.

The major thesis advocated here, on the other hand, is that educational leaders and policy-makers

should move in the direction of adopting an open system perspective for educational organizations. As Hanson (1985) suggests:

> The open system model as applied to change in educational organizations requires an understanding of the relationships between three bodies of theory: open system theory, contingency theory, and management information theory. Open system theory emphasizes the dependency relationship of the school and its surrounding environment. When the needs and demands of the environment shift, the output of the school (and therefore of the teaching-learning process) must also change, if the school is to be an engine of development rather than a contributor to the problems of society. (p. 339)

Contingency theory, which is a derivative of open system theory, states that variable environmental demands require variable organizational responses. Monitoring of those demands and management of responses is accomplished through a basic organizational structure consisting of the supplying systems, the processing subsystems of the organization itself, and the output to the receiving systems. Essential to the integration of these systems is a management-information system that is used to gather precise information and that links external environmental needs with internal structures.

A New Perspective on Change

The first part of this paper draws upon my recent two-year study that examined the empirical information derived since 1980 on the adoption, implementation, and integration of the microcomputer innovation within the instructional program at the elementary and secondary levels in the United States. Nearly 375 propositions extracted from 70 research studies were systematically classified in an effort to map the field. The findings fell into two broad areas: (1) organizational structure and governance, and (2) educational change and innovation.

What emerged from that study was a new perspective on educational change. That perspective is incorporated here and used as a framework for a metasynthesis of research findings that should be of interest to educational planners and administrators. This paper also includes a discussion of implications for action based on the findings. It concludes with the presentation of a case study that serves as a model and illustrates a powerful method for bringing about structural reform in public education.

A Metasynthesis of Findings

The available research information on microcomputer adoption, implementation, and integration was found to be extremely diffuse. It covers a wide range of topics varying from resource analysis through policy-making, inservice training, instructional design, and much more. To provide some coherent structure for the information, the functions of the various subsystems and outside groups that interact in the innovative processes were identified. These functions in turn were related to a model of organizational structure based on modern *contingency theory*. Again quoting Hanson (1985, p. 153), "contingency theory represents an orientation that enables us to conceive of an organization as an open system composed of interacting subunits faced with uncertainty. Through the adaptation of organizational structure, planning strategies, and leader behavior, acceptable levels of certainty can be achieved."

Once the operations of the various subsystems and groups external to the organization were identified, their functions became recognizable as essential to or implicit in the process of educational development. It remained only to relate these functions to a problem-solving model in which the findings were viewed as part of a general effort to improve the efficiency and effectiveness of instruction. This model provided a systematic basis for classifying and synthesizing the research findings.

The information presented here is organized around the various functions that were identified in the research study. These modalities fall under six contextual divisions: setting, resources, governance, implementation, process evaluation, and integration. Following is a summary of research findings under these headings and a discussion of the administrative implications that derive from them.

The Setting

The setting is the sociologic context that describes the existing cultural-environmental factors motivating the decision to adopt and implement an educational innovation. It is a primary source of inputs for decision-making within the organization.

The setting is differentiated into focus and influence. *Focus* includes the conditions and purposes for change that express the educational philosophy of the school district in keeping with evolving societal needs and educational goals. *Influence* consists of all the internal and external environmental determinants that limit or force change. These include sociopolitical pressures, community socioeconomic characteristics, the influence of autonomous groups such as teacher unions, and public policy originating outside the school system at the federal and state levels.

Focus

When a technological innovation like the microcomputer first appears on the educational scene, the evident tendency is to promote the innovation as the solution to a multitude of problems. Functionality is overemphasized. Although the relative merits and utility of the technology may be clear in the minds of the promoters of the innovation, the potential adopters are not always of like mind. The problems of implementation and curricular integration are ignored during the early adoption stages.

When compared with board members and administrators, teachers as a group are the most conservative with respect to the acceptance of microcomputers as well as in their desire to implement them (Adkisson 1985, Fennel 1985). As practitioners, teachers have already developed adequate solutions to their pedagogical problems. Unless preservice education has endowed teachers with the required technical and developmental skills, many teachers are reluctant to invest additional time and energy to incorporate a new technology into their methodology.

Implementation efforts, such as inservice education, have concentrated on the feasibility of use of the microcomputer rather than on its potential for the improvement of instruction. This is a very important observation. The effects of refocusing attention on the need for increasing educational effectiveness and efficiency through use of the microcomputer innovation have not been tested. No recent research information indicates that school systems are consistently moving in the direction of developing the necessary policies, procedures, and programs to facilitate the broad and successful integration of microcomputers into the instructional program.

The technology continues to advance, however. The pending commercialization of interactive optical disk technology, for example, threatens to bypass the classroom teacher in many educational areas. Teaching, if it is to survive as a profession, appears to be heading in the direction of requiring teachers to assume increasing responsibilities as managers of instruction. This observation is not to ignore the powerful and constructive influence of successful

teachers in areas of affective development but to warn that such efforts may be subverted in the process of adapting education to a presently limited technology. Harking back to the early warning of Lewin that "the media is the message," Roszak (1986) warns that our capacity to think creatively is being undermined by the very "information" that is supposed to help us understand it. Data processing replaces thought; "data glut" obscures basic questions of justice and purpose.

Change decisions, based on group pressures to adopt microcomputers, have been more subjective than rational. But rational decisions have been found to be ineffective unless they are made in conjunction with an explicit value system (Bond and Himmler 1985). No philosophical base is generally in evidence, however, meaning that the goals of education relative to microcomputer implementation have not been fully developed. Many schools are apparently too preoccupied with survival in a climate of public criticism and financial crisis (Rogers, McManus and Kim 1985) to give the necessary attention to technological literacy and program development.

On the other hand, the continuing evolution of the microcomputer and the explosion of potential teaching applications have prevented microcomputer use from becoming systematized (Rogers and others 1985). The implication is that teaching methodology will remain in flux as the available media, the methods, and the objectives of education continue to change. Accordingly, strategies for coping with *continuous* change must be developed at every level—from the teacher preparation level to the operational, technical, and managerial levels in the field.

The difficulty in promoting change, therefore, appears to lie both in the focus for change and in the utility of the innovation.

Influence

Among the stronger influences affecting the extent of microcomputer implementation are socioeconomic factors, community pressure, and public policy. Broad recognition of the utility of computers in the workplace has led to increased public demand for computer literacy instruction. Community pressure for the adoption of microcomputers is strongest in the more affluent school districts where willingness to pay is most characteristic (Honeyman 1984). Solutions to problems of student access and equal educational opportunity are contingent on local resources and policy decisions. It is only in schools with lower student-to-computer ratios (less than 50 to 1) that a significant degree of microcomputer implementation has been found (McGee 1987).

Considering that the ideal ratio needed to provide free access is two students to one microcomputer, few schools have been able to afford the level of funding required to provide such ratios. Even where means are found to acquire microcomputers in low socioeconomic status school districts, the equipment may fall into disuse for lack of continued financial support rather than lack of methodological interest on the part of teachers (McGee 1987).

Incongruously, teachers whose needs are well met in terms of a satisfying school climate are sometimes disinclined to take on the added burden of mastering a new technology and changing their instructional development patterns accordingly (Clerc 1985). Such a disfunctional stance and the strong influence of socioeconomic determinants reflect the apparent need to revise educational structure in terms of leadership, incentives, and goal consensus as expressed through public policy.

Resources

The other input category is resources. This is the synergistic context where the human, material, and financial resources are brought together in support of innovative efforts. The subdivisions are agency, audience, and support. *Agency* consists of the proactive human elements who attempt to sponsor and administer change. *Audience* refers to the target groups who are expected to implement change— the teachers and school administrators who are to integrate the microcomputer into the instructional program. *Support* is the subdivision that takes into account all the factors that provide underpinning for innovation—financing of supplies, equipment, and facilities; providing personnel, inservice training rewards, and time to sustain the innovation.

Agency

The current limits on microcomputer diffusion appear to be a matter of organizational structure and available resources. There has been no widespread movement on the part of federal or state agencies to support or take substantial responsibility for the diffusion processes (Rogers and others 1985), including provision of equipment and training. This responsibility remains decentralized in the hands of local authorities.

Whereas individual teachers often act as innovation initiators (Schimizzi 1983), school principals must take responsibility for applying the new technology because, as school leaders and managers, only they are able to manipulate the incentives to facilitate

adoption and implementation (Rogers and others 1985). On the other hand, the establishment of new facilities and support services represents an important change in the school's organizational structure. These changes involve expanded individual capabilities and responsibilities on the part of teachers. As teachers continue to move in the direction of becoming instructional managers rather than purveyors of information, adequate compensation and incentives are evidently not being tendered.

Audience

By far the greatest amount of research information was collected on teachers as the respondent audience—the potential adopters, implementers, and integrators of the innovation.

Faculty attitudes toward computing implementation are strongly affected by several factors: (1) by knowledge of the value of microcomputers in instruction gained through operational exposure over time, (2) by the kinds of computer programs they choose to use, and (3) by the reshaping of group dynamics within the classroom setting through such use (Winner 1983). The underlying concept, which is common to most successful training and learning situations, is this: unpressured exposure to new ideas along with adequate time to assimilate, experiment, and practice new procedures promote confidence and willingness in use.

Most negativeness is attributable to those teachers who are untrained in computer-assisted instruction and therefore overlook the key role of the microcomputer in supporting teaching-learning activity. They regard the microcomputer rather as an instrument able to replace the teacher (Ferraris and Sassi 1985).

Attitude intensity toward microcomputer integration evidently has a closer association with operational experience (affective knowledge) than with computer literacy (cognitive knowledge). It is found, however, that positiveness toward the innovation does not increase unless the exposure is accompanied by enjoyment or gained through voluntary participation (Bradford 1984). This relationship has important implications for structuring teacher training at both the preservice and inservice levels.

Concerning teacher training requirements, few prerequisites appear to be in place regarding teacher computer literacy either for certification or as expressed in local hiring practices (Adkisson 1985).

The progress of teachers in acquiring knowledge and gaining experience in the area of instructional microcomputing has been closely studied by several researchers. It was found that most teachers are initially engaged at the mechanical level of use, exhibiting associated self-concerns about the use of the computer. There follows only slow progress toward the stages where teachers, having gained competence in use, exhibit concerns about the consequence of computer use on students (Noyes 1983).

The most important finding concerning inservice teacher education efforts is that there was no difference in profiles of concerns when comparing group data for teachers who had informal training in microcomputer use at the building level and data for those who had no training (Wimmer 1984). The implication is that unless such training is geared to the specific needs of the individual teachers involved, there will be little or no impact on their competency of use.

The actual type of computer use by teachers varies according to the level of teacher computer education (Earl 1984); that is, teachers appear to exhibit greater perception of the potential use of the microcomputer and exercise more discretion in its actual use as the computer education level of the teacher increases. Among the reasons given by teachers for not using microcomputers are lack of access, lack of funding, not being involved in the decision-making processes, and not being given time to learn about microcomputers (Johnson 1986).

One key insight subsumes all the findings regarding the behavioral aspect of the target audience: because there is a feeling of powerlessness among teachers, it is the sense of professional growth and school improvement, as evidence of teacher power to affect their environment, that is crucial (Rubin 1987). That is, if it can be demonstrated to teachers that they have the capacity to acquire technological control of the microcomputer and if it can be further demonstrated that use of the microcomputer can increase teachers' instructional effectiveness, then they will gladly embrace the innovation. Such has yet to be demonstrated for the plurality of teachers.

Support

The inability of school districts to supply adequate financial support is clearly a major obstacle to the continued growth and development of microcomputer programs (Schimizzi 1983). Even with hardware costs declining, the capital burden of providing enough machines to ensure equitable access and the sizable maintenance and replacement budget create economic hurdles that most districts cannot surmount (Rogers and others 1985).

Movement from limited use of microcomputers to parity for all students requires major organizational, curricular, and methodological changes in all grades, in conjunction with substantial expenditures for facilities, renovation, equipment, materials, main-

tenance, and support services. A few highly motivated districts have found creative ways to finance such expenditures (Peper 1986). However, an integrated approach to seeking financial support from outside the district is seen as essential.

The installed base of microcomputers in the public schools has been increasing at only a moderate rate in recent years. There is also evidence that in some low socioeconomic schools, microcomputers are falling into disuse. This is an incredible situation considering that the potential of this technology has barely been tapped.

Because implementation of computers represents a distinct educational technology, their successful integration in the curriculum requires unique site, district, and regional supports. Among the supportive factors that have been identified and that need to be stressed under present structural arrangements are these: (1) strong leadership from principals in support of teachers and instructional computing; (2) the school and the district containing people with initiative, expertise, and altruism; (3) the innovation molded to fit into existing curricular priorities; (4) uniformity of style and standards throughout the school; and (5) stability within the faculty (Meister 1984).

The next two sections of the organizational model incorporate the characteristics of the linkage or diffusion strategy, the means to the end of instructional reform. The two main divisions, governance and implementation, respond to questions about who is responsible and what the issues are; they also deal with the who, when, where, and how of the adoption and implementation strategies.

Governance

Governance signifies the authority of the organization, the right to modify organizational goals, and the responsibility to regulate collateral efforts. It dominates the decision-making context of the organization.

Policy-making, the single subdivision in this category, represents the directive mode of the organization. Policy-making consists of the decisions and commitments, including those arrived at cooperatively, that direct administrative action regarding, in this instance, modification of teaching practice and the selection, use, and support of the associated technology.

Only one major research study has been conducted on the incidence of school board policy and of the issues involved in policy-making relative to the instructional use of the microcomputer innovation. The indication is, however, that boards of education have generally been remiss in providing guidelines for administrative policy in the area of implementation and curriculum integration.

Policy has not been annunciated regarding such vital issues as curriculum applications, computer literacy, equal access, inservice teacher education, incentives, resource allocation, software selection, teacher hiring practices, and advisory group composition (Adkisson 1985). Whether by financial default or submission to competing pressures to consider other priorities, most school boards have not been able to solve the problem of providing equal access and equal financial opportunity for children with respect to the use and benefits of instructional microcomputing (Adkisson 1985).

The most successful diffusion seems to occur where implementation is considered as part of a thorough reexamination of school goals with concordant policy pronouncements (Rogers and others 1985). The implication is that expression of the authority of the governing body in terms of formal policy provides a primary motivating force within the organization. Policy is needed to define and set the action goals of the school district and thereby provide an essential dynamic of the change process.

Implementation

Implementation embodies the developmental context where decisions are made about strategies that represent the means for gaining desired ends. Several subdivisions—analysis, logistics, and administration—represent the resolution, strategic, and executive modes respectively.

Analysis dissects the relationships between the outputs of the system and resources/conditions required to achieve them. It also establishes the criteria of accomplishment. *Logistics* is the planning, design, and coordination of the diffusion strategies, which include organizational and professional development; provision of support personnel; and procurement of materials, equipment, and facilities. *Administration* includes leadership of the decision-making cycle associated with development and management of the intervention and transformation procedures.

Analysis

Clearly, as Bond and Himmler (1985) have observed in the field, ambiguity in the implementation process is linked to ambiguity in the adoption process, which is a reflection of ambiguity concerning educational computer goals. Planning, as such, then becomes the rationalization of the adoption decision.

This means that innovation bogs down in the implementation stage and little integration of the innovation into the educational program will ever take place.

Microcomputer implementation, like most change involving social systems, seemingly does not proceed in a series of sequential steps. Neither can the process be imposed unilaterally. Those who would hope to direct such development must plan strategies that influence operations at all organizational levels within the system. They must also influence the level of support in the external environment.

Development is a comprehensive process that culminates in adaptation—the effective use of the technology. Clearly, leadership must be applied and energy exerted continuously through the six successive developmental stages identified by Winner (1983): awareness, interest, evaluation, trial, adoption, and integration. *Awareness* is the critical first stage in the implementation process. Then, *interest* must be maintained through the initial period of discomfort associated with lack of knowledge until teachers move on to the exploratory and experimental stages. If these first two stages are unforced, *evaluation* and *trial* take place in the best heuristic manner. It has been found that only then do teachers show interest in more permanent computer access for students and that curriculum development actually commences, finally culminating in *adoption* and *integration* of the technology (Winner 1983).

The components of a conceptual planning model for microcomputer integration have been partially validated through the research. They include a supported task force, district assessment and goal setting, a coordinating committee for applications (courseware selection), staff inservice training, and process evaluation (Metschke 1986).

Among the impediments to effective planning for computer education, the following appear to be most important: lack of control of hardware decisions, unavailability of high quality educational software, lack of adequate computer-based curricula, and lack of appropriate training for program implementers (Linn and Fisher 1984).

Logistics

Most of the research literature has not so far addressed the comparative advantages of the various microcomputer diffusion-linkage strategies. It is hoped that the basis for major problem-solving strategies is implicit in the issues discussed here, because there is no cookbook approach to educational administration and leadership. By definition, contingency management theory rests on the existence of a communication structure within an organization that provides the necessary inputs for decision-making. It is the challenge of administration to take the available information and exert the necessary leadership to meet contingencies and find satisfactory solutions.

There are, however, a few important generalizations that have been derived through the research literature in the area of inservice education. Inservice teacher education for teacher microcomputer literacy and instructional use has the same dimensions as preservice programs at the university level. Few school systems have the resources to conduct such a program effectively. Considering the drought of preservice preparation in this area, however, many school systems have had to proceed as best they can.

Despite the severe impediments to conducting effective inservice programs within the structure of the typical educational system, there has been no choice but to do something until higher education has improved its preservice training. The most important training components of teacher inservice programs for microcomputer literacy appear to be (1) presentation of theory, (2) modeling of skills, (3) practice in simulated and classroom settings, (4) structured and open-ended feedback about performance, and (5) coaching (hands-on inclassroom assistance) in the transfer of skills and strategies to the teaching environment (Joyce and Showers 1980).

A number of inservice training provisions are also recognized as being advantageous in achieving higher levels of teacher participation, teacher satisfaction, and effectiveness in use. Winner (1983) outlines these provisions as follows:

1. program content that reflects needs of elementary teachers as generalists
2. an attempt to engender an understanding of computing as an entity in which there is the need to incorporate process-learning problem-solving strategies
3. voluntary attendance at training sessions
4. no administrative pressure to force computer usage
5. the instructor able to structure the program to provide for the particular needs of individual staff members
6. spacing of sessions consistent with the time needed to learn new tasks and strategies and to allow time for exploration and experimentation with the material presented at each session
7. use of formative evaluation methods at each session to secure continuous feedback
8. allowing staff to participate in both the design and the learning phases of the program

Administration

Participation of the principal as change leader, particularly at the elementary level, and as manager of implementation strategies appears to be critical (Elliott 1984) to the maintenance of effort over the three- to four-year period required to pass through all the implementation stages. Further, it has been determined that the chief motivation for the introduction and utilization of microcomputers at the elementary level comes from "administrative initiative" (Wilson 1982).

It might be noted here that the teacher hiring practices of many principals, whether guided by policy or not, were generally found faulty in not emphasizing the criteria of training or experience in microcomputer use (Schimizzi 1983, Zartman 1984). The consistent employment of such criteria would appear to represent a viable means for improving the technological literacy level of school faculties.

The final section of the organizational model incorporates the output of the system. Two divisions, process evaluation and integration, respond to questions about the mission and goals of the system. They also respond to questions about how the innovation has taken hold and whether or not the system exhibits the desired improvement in efficiency and effectiveness.

Process Evaluation

Process evaluation produces both immediate and long-range information on the effectiveness of planning and implementation activities within the organization. *Feedback* is the name for the communication mechanism that allows an organization to track its own actions so that control can be exerted and progress monitored. Feedback consists primarily of transactional communication between participating groups both within and without the organization. *Accountability* implies a more formal demand for information by policy-makers. This can create an area of tension between the governing authority that determines institutional goals and the assumed authority of professionals to unilaterally determine the processes (means) for attaining them.

Feedback

Very little research information is found in this area. The feedback process is evidently assumed to be implicit in the decision-processing activities of the linkage-diffusion channel. Several key perspectives are assumed, however.

The feedback function is a critical component of system operation. It is the source of management information for coordinating, controlling, and modifying implementation procedures and processes within the organization. It is also the source of external information from the receiving systems in the external environment. The receiving systems in this case include business, industry, and higher education. Feedback from these systems provides part of the input for revising system goals and modifying internal processes accordingly.

Accountability

Also included under this definition is accountability, which is the specific responsibility to diagnose and report on efforts to attain policy goals. Accountability systems have been designed to help schools evaluate their goals and the procedures for attaining them. The problems of the technical-behavioral interface that are revealed in a diagnosis of organizational accountability appear to be the same problems that apply in the implementation of the microcomputer innovation. Resistance to accountability systems within the educational organization is apparently related to the degree of ownership teachers feel toward the innovation, the nature of new task demands, and so forth (Hahn 1978).

A crucial distinction needs to be made that strongly affects the motivation of teachers and the degree of ownership felt. There should be no question in the minds of teachers that it is the prerogative and the responsibility of the school board as the governing authority to set policy goals. Educational goals and standards of accomplishment are not negotiable. These specify the needs of the society at large, and they define the purposes of the educational system. While it may be desirable that governing boards work cooperatively with citizen and professional groups to obtain representative inputs, this is not mandated.

Integration

Integration represents the final stage in the change process. It represents the technological transfer context, which refers to the capabilities of teachers in utilizing the instructional innovation (the microcomputer, in this instance) by incorporating it into their teaching methodology. It also includes the effective transfer of the benefits of the technology into the curriculum of the schools and evidence of improved student learning and performance. Three subcategories can be differentiated: function, delivery, and assessment.

Function

Function refers to acquired teacher instructional design capability in relation to microcomputer use, the actual methodology of use, and teacher literacy and facility in the area of microcomputer technology.

It is clear from the research findings assessed in this study that instructional design and development is a critical area of preservice preparation. Evidently, the development of the associated skills and the gaining of experience in this area provide the foundation for all instructional methodology and curriculum development. A pronounced weakness in *instructional design skills* on the part of many teachers is held to be responsible for a lack of effective exploitation of the educational potential of the microcomputer (Montague and Wulfeck 1983, Mukasa-Simiyu 1985).

The multitude of instructional design skills that are involved in the development and design of individual teaching methodologies are also recognized as applicable to the optimal design, production, and evaluation of educational courseware (Taylor 1986). The implications are twofold: (1) educators who are unfamiliar with the full range of subtasks involved in instructional development are not in a position to judge the quality and effectiveness of available software and courseware, and (2) unless commercial designers and developers of educational software are fully cognizant of and experienced in the use of the skills and associated subtasks, they will likely offer an inferior product.

Two basic types of curriculum integration have been identified: (1) the applications curriculum that utilizes various kinds of computer courseware, and (2) the computer science oriented curriculum that has computer literacy as its goal (Peper 1986). Both orientations are often evident at different levels within the same system, and it appears that critical thinking skill development can be accommodated in both types.

Delivery

Delivery constitutes the organizational aspects of the provision of support services to ensure the continued functioning and evolution of the innovative program. The development and establishment of critical components of the delivery system have been discussed in the section on implementation under the headings Analysis and Logistics. The specific applied aspects of the delivery of services are well covered in guidebooks by Lathrop and Goodson (1983), Pogrow (1983), Glossbrenner (1984), Adams (1985), and Garson (1987). A concise set of implementation guidelines has also been published by Vakos (1986). His ten steps for putting together a comprehensive plan for computer education are as follows:

1. needs assessment
2. statement of philosophy
3. board policies
4. administrative procedures
5. learner goals
6. instructional priorities
7. equipment needs
8. preparation of bid specs
9. integration
10. evaluation design

Assessment

Assessment consists of summative evaluation for the determination of teaching-learning effectiveness pursuant to the utilization of the innovation, assessing instructional design capabilities, evaluating changes in learning outcomes in practice, and following up on graduates of the system.

The impact of microcomputer use on teaching-learning effectiveness—assessing instructional design capabilities and evaluating resultant changes in learning outcomes—appears to be a highly neglected area of investigation. On the other hand, it is only fair to recognize that the efficiency of microcomputer programs in the schools cannot be fairly measured when the programs are in the early years of development (Honeyman 1984). This is due partly to the lack of proficiency on the part of teachers, who are inexperienced in the use of new methodologies, and partly to the constant influx of new computer applications.

At this point, the six divisions of the organizational model have been described and a general synthesis of key research information in each of the categories has been provided. Additional insight may be gained by reference to the individual propositions classified in the original study (Gillman in press).

The next section is devoted to a discussion of some important implications for action that arise when the information is examined from a problem-solving perspective. Although more research may be needed to reduce the aura of speculation around some of these conclusions, there exists a definite call for action based upon what is presently known. This analysis is a partial response.

General Implications for Action

Implementation of the microcomputer innovation appears to represent a test of the adaptability of public education institutions. The above findings converge in areas relating to policies, procedures, and program integration. Although the evidence is diffuse, it is abundant and it all points in the same direction: the present structure of education is inimical to rapid or spontaneous change. In contrast, technological advances are compressing the time scale, and the rate of social evolution is increasing exponentially. Thus, the challenge to education is to find a way to help the profession adapt more readily to changing social requirements.

First, let us return briefly to a consideration of contingency theory as it relates to organizational decision-making. The value of this emergent theory is that it works to overcome the tendency of organizations, including school systems, to avoid uncertainty and the corresponding element of risk. As Thompson observes, "Uncertainty appears as the fundamental problem for complex organizations" (1967, p. 159). The diverse forces in an evolving society, particularly a pluralistic society such as ours, introduce elements of uncertainty that cannot be avoided. The leadership role is particularly important because contingency theory interprets administrative responsibility as the strategic confrontation of risk rather than its avoidance. In a rapidly changing world, the administrator evidently has two choices: (1) play it safe and be overrun by the tides of change, or (2) plot a course into the future where risk is balanced by gain.

Without perfect knowledge, the element of risk cannot be eliminated. In the case of educators, the tendency is to be conservative—repeat past procedures and achieve a modicum of results. Change by small increments has been the traditional way of reducing risk in meeting new demands. Rapidly changing needs, however, are outpacing the traditional mode of response. This means that teachers and administrators alike must find ways to become more responsive.

The way to become more responsive is to experiment—to confront risk and keep trying until success is achieved. This is the heuristic technique that combines educated guesses with iterative cycles of strategic effort and refinement. As has been demonstrated in the sciences, this is probably the most effective approach to problem-solving in situations in which many of the variables are beyond control. It does require more work, however, and access to the best information that is available. To experiment with children's education can only be justified on grounds of striving for increased effectiveness and excellence. The commitment must be to demonstrate that such goals have been met.

The evidence from the above research indicates that structural change is needed in public education, change centering on three types of reinvention: operational, technical, and managerial. These themes are implicit in the commentary that follows.

New Educational Direction

Being computer literate is becoming as important as being literate in the traditional sense. Computing is the new basic in education. It is the new bridge between the humanities and the sciences. Educators cannot ignore this essential connection. Adams (1985) expands the concept: The liberal arts give educators both the intellectual tools and the understanding of what they are teaching and why. The characteristics of effective instruction have led us to use art, drama, music, and literature as a bridge to the physical sciences and technology. The most successful educational programs build on the elements of challenge, fantasy, and curiosity in the process of integrating technology and the arts. Teachers now have an educational tool that allows them to amplify these elements to a maximum. The microcomputer has become a liberating force in education.

An extraordinary change is needed in the way teachers educate their students. Microprocessors that lie at the heart of an immense technology are resulting in a synergy between fields of endeavor that is causing knowledge to explode. Educational goals must be adjusted to accommodate the impact of technology on society. Such an adjustment implies two primary areas of responsibility for education: (1) incorporating computer literacy as an integral part of the curriculum at all instructional levels, and (2) exploiting the potential of this technology for improving instructional methodology. Microcomputer technology offers the possibility of truly individualized instruction tailored to fit the special needs of each student. In the process, microcomputers are becoming the object of instruction, the medium of instruction, and the managers of instruction. This transformation cannot be completed, however, unless the concepts of power and political priorities that

direct these changes come under scrutiny.

Correlates of Policy-Making

The correlates of educational policy-making relative to microcomputer adoption and use by teachers are extremely important. The fundamental issue is not philosophical, but rather structural. The primary role of boards of education has been obscured by educators who, through default of the boards themselves, have usurped the governance function of the schools. When examining the problem of strategic change in education, particularly in relation to technological innovation, the fundamental question arises as to where the primary initiative for change should originate.

At present, there is no single answer that can be argued convincingly. First, there is an obvious distinction between educators as innovators (those few who have their fingers on the pulse of change) and educators as implementers (those who are professionally responsible for operationalizing the technology). Although awareness of the innovation and recognition of its educational potential may originate within the professional ranks (though in this instance, much of the impetus has come from outside the educational establishment), it is advantageous that the initiative for adoption and implementation should emanate from the seat of governance of the system: the school board and its chief administrative officer, the superintendent. It is their responsibility to be mindful of the ultimate purposes of the organization and to direct it toward those ends.

Written policy by the board of education, even if tentative, can accomplish two things: (1) by specifying and ratifying innovative goals for the school system, policy provides an authoritative impetus to prioritize professional efforts in bringing about change; and (2) by ratifying such goals, the board alerts the community and commits itself to the necessity for multilateral support.

Teachers and school administrators are thus fully authorized through the policy to plan and take responsibility for implementation and integration of the innovation. They *also* become obligated to meet corresponding expectations with respect to evaluation and accountability. Theoretically, this action will permit administrators, managers, and other educational change agents to exercise their leadership with a greater degree of cooperation and responsibility on the part of practitioners.

If an educational innovation is rational and demonstrably effective, then it is necessary to circumvent the infighting that can occur when the loosely coupled subsystems of an organization resist change in order to maintain their existing operational priorities. It is at precisely this time that leadership must be exerted so that mutual accommodations will be made in order to ensure the satisfactory implementation of the innovation.

The board and the central administration must remain attuned to the changing needs of society on *all* fronts. Second, they must interpret those needs in terms of definite educational goals. Third, they must establish concordant policy to guide administrative policy. Fourth, such responsibility requires accountability on the part of the organization, including evaluation of both the processes of instruction and the human product.

This list of responsibilities is a tall order; in my opinion, most boards of education do not have the knowledge, professional insight, or experience to be capable of handling such responsibility in a proficient manner. While many boards look to the community for assistance, the necessary resources are not usually at hand. Neither are communities being serviced in this regard by most state boards of education. Thus, the major responsibilities for *both* policy definition and administration rest with the superintendent of schools.

For the chief executive officer of any organization, including the superintendent of schools, to be in the position of determining institutional policy as well as carrying it out often proves untenable. The proverbial "house of cards" cannot stand. The arrangement also represents an exceedingly weak aspect of organizational structure, because it leaves to the organization the responsibility of determining its purposes and the means for accomplishing them rather than having the organization respond to the needs of the marketplace where it will compete in terms of the quality of its product. Unless the superintendent is an extremely adroit educational leader (supplied with unusual stamina and able to control the use of time by subordinates), the professional staff may come to view such efforts as the unilateral dictation of educational policy. Teachers, who are particularly prone to exercise autonomy themselves, can become extremely uncooperative.

On the other hand, if the superintendent invests the time and energy to obtain input and consensus at the grassroots level, from the practitioners themselves, the board may prove to be suspicious of the intents and therefore unreceptive. The tendency is to dismiss items that are not well understood and to deny fiscal support. If the superintendent has also fallen into the trap of having to educate the board on every nuance of the educational process, the demand for additional "research" information may postpone decision-making interminably. The result is a growing backlog of unresolved problems with the school

district treading water in the interim. The superintendent becomes vulnerable on both sides, and when the disenchantment grows vociferous, the superintendent is out of a job, a new cycle begins, and the educational system stagnates.

The crux of the problem is that most boards are inexperienced and naive when it comes to educational policy determination. It is not enough to be philosophically attuned to the needs of society. Boards of education should be able to translate those needs into educational goals specific enough to serve as guidelines for the establishment of concordant administrative policy. More than that, to assess institutional effectiveness, the policy-makers should be in a position to specify those criteria that will be used as a basis for accountability and around which evaluation measures will be designed. To do less is to cut out the control mechanism needed to steer the organization.

Given the present governance structure of public education, most educational systems are handicapped because there are simply not enough superintendents with the stamina and adroitness to walk the tightrope of educational leadership across the chasm of innovation and change. (The case study at the end of this paper illustrates what can be accomplished in the way of instructional improvement through technological advancement even under existing organizational structure.)

Approaches to Restructuring

Fundamental restructuring appears to be necessary if we, as a country, are to advance toward the goal of improving public education; however, the necessary initiative has been slow to build within the ranks of education itself. Loose coupling and special interest groups militate against it. Of course, such restructuring is part of the much broader societal problem with which we are now struggling: achieving consensus on social and ethical goals and reorienting human behavior accordingly. Effort and leadership have to originate at many junctures for the slow give-and-take process of social integration to proceed.

The broadest leadership is needed to mount a multilateral effort to improve education while simultaneously attempting to exploit and integrate the use of the microcomputer as an educational tool. An intensive effort at analysis, planning, and development is required nationwide. Much of the preliminary investigative work has already been done by other groups. It is now time to act.

Some states have already exerted initiative along these lines. For example, the California Commission on Educational Quality was created to make recommendations for overall changes required to reestablish educational excellence. The commission's report was presented to the governor in June 1988 with extensive strategic solutions to existing organizational problems that could well be shared with a wider audience.

I would like to see a nationwide or even broader coalition composed of representatives from all educational levels, including the military, and from all receiving groups in the greater society—those who have a patent interest in the goals of education. This group would be charged with the responsibility for arriving at a major consensus on the goals of education that should be reflected in educational policy and for making strategic recommendations for revamping the structure of public education so that such policy can be carried out. Change protocols would be built in and become a permanent part of the system.

Several possibilities come to mind. The first attempts to preserve states rights in the area of public education while simultaneously recognizing the urgent need for national consensus on the goals of education. The suggestion is that the *states* jointly appoint, perhaps through the auspices of the National Governors Association, a confederated commission on educational quality to conduct the work on a full-time basis. Authority could be delegated, costs underwritten, and strategic recommendations ratified by all the state legislatures. The group would also maintain a research arm, perhaps working through the universities and in conjunction with commercial developers, to work on the problems of instructional design and to maintain currency with the rapidly changing technological developments that affect education. Annual symposia and online databases would provide access to the information by practicing educators as it is being developed.

If no centralized initiative is forthcoming, a second possibility is that a private foundation like the Carnegie Foundation would organize such an undertaking, underwrite the costs, and publicize the recommendations until recognition is gained on an agenda for change and action is taken.

A third possibility is modeled after the workings of the California Business Roundtable, which is an organization of chief executive officers (CEOs) of over ninety of California's major corporations. The Roundtable believes that the state's future rests on the vitality of its public education system. It recognized that as our country shifts to the information age and global competition, the K-12 education system is being confronted with ever greater social demands and technological change. The CEOs became committed to working with educators to develop an outstanding educational system to meet these chal-

lenges. The Roundtable therefore funded a project to recommend how this goal could be achieved.

A consulting group was retained to meet with educators, political leaders, legislative members and staff, community leaders, and citizens concerned with education. Using ideas gleaned from these discussions plus concrete examples of effective practices throughout the country and the world, the group formulated a series of recommendations that outlined a design for public education in the twenty-first century. The report was endorsed by the California Business Roundtable, released to the media, and submitted to the state legislature for consideration.

Planning and Implementation

If Hanson (1985) is right about the need to fully understand the technology of an innovation as a prerequisite to implementation efforts, then educators have been in the unenviable position of having to put the cart before the horse in their endeavors. Under pressure to implement the use of the microcomputer in education, the schools have been attempting to adopt the microcomputer at a time when many teachers lack both necessary understanding of what this education tool means and experience in its use. The college preparatory programs must ease this burden by providing programs with the proper scope for training preservice teachers in the implementation of microcomputers. The schools themselves are extremely hardpressed, within the bounds of time required for the education of children, to undertake inservice training of this kind. Yet, such activity is absolutely essential as society advances into the information age.

While the integration of microcomputer technology into the educational program is the present focus, it is only one facet of the larger problem requiring solution. The problem is to bring about an increase in educational effectiveness and efficiency that will have a truly positive impact on our culture. Microcomputer implementation represents neither the whole problem nor the solution to the problem. The microcomputer is merely a tool; such a tool, however, can be the catalyst for improving education. Integration of this technology tests the entire fabric of public education and the ability to cope with change. Management of the problem is forcing a fundamental reassessment of the way the institution of public education presently operates.

Limited Capacity to Change

In terms of sheer numbers, there is no question that the schools are adopting the microcomputer; however, the extent to which the potential of this technology is being applied to revitalize and enhance the curriculum of the schools is an open question. Many schools have acquired microcomputers. There is a distinct difference, however, between the dynamics of adoption and the dynamics of use of this powerful tool. The requirements for fully exploiting this technology are such that the schools find themselves constantly challenged to foster curricular change. This is an uncomfortable situation for many professionals, but change and the constant need to adapt are evidently givens of the age in which we live.

The capacity to change and be comfortable in the process does not match the conservative mind set, but it is becoming the mark of the successful individual. The ability to change and adapt is principally a matter of experience. If problems can be analyzed and solved quickly and easily (which the microcomputer helps to do), then there is room for satisfaction, an important element in the quality of life. Adams (1985) portrays the success cycle as consisting of practice, proficiency, and pleasure. The trick is to solve one's problems quickly, so there is still time to practice and gain proficiency from which pleasure can be derived—a new goal for education!

Process Validation

Once new goals of education have been established and documented, they can be interpreted in terms of specific process objectives. These objectives can then be incorporated directly into teaching methodology or into educational software and commercially developed courseware. If these process objectives are developed jointly with professional educators, they are at once validated. Until recently, however, the necessary mix of qualified courseware designers working in collaboration with practicing educators to produce validated instructional materials has not been sufficient to create a market large enough to attract the investment interests of the software industry.

The validation process could be speeded up considerably by employing task forces of teachers who would work jointly with commercial developers in the design of computerized courseware and other media for use in the schools. Validation would open the doors to evaluative research. This does not mean using young people as guinea pigs. It means trying well-designed strategies that have been validated on the basis of what is known about educational theory.

The other advantage of validation is that this at once allows the free enterprise system to begin creating a market. Many manufacturers and developers already have a vested interest in education because of the potential of computer technology in this area, but without a market they cannot afford to invest too heavily. This is the incentive that entrepreneurs need to begin working in partnership with education.

Change Takes Time

Constructive long-term change cannot be forced. It takes time for people (teachers), no matter how willing, to gain control over the processes associated with the use of an innovation like the microcomputer. Only gradually does the innovation gain usefulness as an instructional tool, wherein teachers begin to effectively integrate its use into their methodology. Technological literacy is a function of microcomputer exposure over time. The change process bogs down when change agents attempt to force or hurry the process of accommodation that is the necessary connection between the innovation and its potential use. However clear that potential is in the minds of the innovators and change agents, they must work consistently and patiently for several years for effective change to come about.

Challenge and Opportunity

If the microcomputer is to be successfully assimilated, if its potential is to be effectively utilized in the educational process, then some careful analysis needs to be done concerning the complex organizational setting in which these changes are taking place. There are many constraints on full implementation of this technology in education, and the planning and development aspects of this undertaking need to be explored more thoroughly. It strikes me that public education is now faced with both the challenge and the opportunity to advance the educational profession from an art form to a more scientific undertaking in which not only the highly talented students become truly successful but the vast majority of individuals can be educated to participate constructively and lead more productive and fulfilling lives in the world's rapidly evolving civilization.

As a counterpoise to the many impediments to educational change cataloged in this paper thus far, I present the highlights of a case study that illustrates how one outstanding school district is pioneering in the area of educational planning and development.

Opportunity 21: A Guide to the Twenty-First Century

Opportunity 21 is Sacramento City Unified School District's resounding pledge to the future of education. It is the name for their strategic plan for leading the children of Sacramento into the twenty-first century and the age of information. Most commendable is the fact that the plan is based upon a thorough analysis of future trends and the recommendations of the community. That plan is now being implemented.

What is even more notable than the goals and directions themselves are the action strategies that are being utilized to bring the plan about. The plan is updated annually with a commitment to specific actions that will be taken in seven priority areas: (1) student achievement, (2) human resources, (3) financial resources, (4) integrated education, (5) at-risk students, (6) organizational effectiveness, and (7) community involvement. Progress on the action plans is monitored on a quarterly basis.

Sacramento, the capitol of California, is in the midst of vast economic, social, and political change that is occurring throughout the United States and the world. The district's leaders recognize that what should be a bright future as a democratic, pluralistic, creative, and livable city can be battered and torn apart by the destructive elements of change if they do not act to protect, improve, and pioneer new paths of public education. The fundamental challenge to educators and citizens is to foresee change and shape it to their benefit.

The following description is indicative of the kinds of educational activities that are beginning to issue from a bellwether state like California. The Sacramento City Unified School District (SCUSD) is one of five school districts to receive a State Model Technology Schools grant. This three-year grant is to help fund the development of model programs that integrate educational technologies into the programs of the schools. Other school systems throughout the country are also active, and their activities should also be examined. This case has been selected because SCUSD is well advanced in its planning, and the work serves as an especially powerful model for stimulating constructive action on the part of the entire educational community.

The next few sections describe the planning and feedback processes that I believe are critical to educational progress and the full integration of educational technology into the educational program of the schools. The fit of Sacramento City USD's developmental procedure with the innovation model presented at the beginning of this paper and the extent to which that procedure is overcoming the impediments delineated in the research literature are beyond coincidence. This case study provides further evidence of the power of contingency theory as a basis for understanding organizational functioning and for designing effective operational procedures for the management of risk. Much of the information that follows is digested from the documentation for the Sacramento City Unified School District strategic plan itself.

Strategic Planning

Strategic planning is an activity that identifies future needs and makes provisions for them by setting goals, by developing activities and timelines, and by allocating human, fiscal, and material resources necessary to meet the stated goals. It provides a framework for decision-making and goal-setting. In concise terms, strategic planning is a process for maneuvering an organization over time and through a changing environment to reach its goals.

Strategic planning, as exercised in Sacramento, is based upon the dynamic theory of the school district. The view is that there is no possible way for present and future conditions to remain constant in an evolving society. External and internal environments such as the changing needs of students, demographics, and economics have a profound impact on the school district, necessitating plans to cope with the unpredictable future. This theory rests on the assumption that, regardless how uncertain the future may be, plans must be developed considering all factors that may have an impact on the school district. Quite often it is a matter of forecasting and determining probabilities.

Strategic planning is more than a simple, one-dimensional planning method. It is a multilevel planning system that allows the school district to consider the future and make provision for it while providing a framework for total management of each subunit and employee within the district. Strategic planning gives information for decision-making at each level of the

organization and provides the process to move the district toward stated goals and objectives.

We now turn to a detailed description of the educational technology portion of the strategic plan. This is one of several program plans (curriculum/instruction, finance, and human resources) developed from the priorities identified in the district's strategic information base.

The Educational Technology Plan

Educational technology is deemed essential in meeting the need for a vastly more productive educational system. It has the power to enhance the instructional program, to improve student academic performance, and to provide effective and efficient classroom, school, and administrative systems. However, it is recognized that the potential of educational technology has not being fully realized because not all the elements of an effective educational information system have been integrated into the instructional, managerial, and operational functions of school districts. In Sacramento, strong leadership is being exerted in this direction.

Need for Information Systems

Information today is an important part of the political, social, and economic structures within which the school district operates. Information is an important resource in the management and operation of an organization. In school systems, it is also used to address the instructional needs of students and to expand and enhance the district's curriculum base. New technologies are introduced every day that increase the speed and efficiency with which data are transferred, stored, and retrieved. Therefore, information systems must be planned for and managed appropriately if they are to be best used to provide the students with the educational resources they need to succeed. Decisions regarding the selection of hardware and software, the allocation of economic and human resources, the revision of organizational structure, and the improvement of curriculum and instructional strategies must be made today.

School districts are both producers and consumers of information. They use information in decision-making, problem-solving, instruction, management, and operations. In order to fully utilize these information resources, new technologies need to be purchased, and employees and students need to be educated in their value and use. However, poorly planned and oftentimes fragmented systems cannot handle the overwhelming load of new information. Without some type of unifying plan, information resources can be lost or misused and the costs of managing and operating these resources can escalate quickly. More important than this, though, is the need to make information and tools available to students that will allow them to compete in the developing information society.

Based on information derived from an "environmental scan" as well as knowledge gained by review of literature and research studies, the district was able to identify a "preferred" future in the instructional uses of technology. That preferred future integrates information and its products and services into a unified system called an "Information System."

An *information system* can be defined as the people, procedures, resources, and equipment necessary to collect, process, retrieve, and transmit information within the organization. This is an actualized definition of the information feedback loops illustrated in the generic open system organizational model at the beginning of this paper.

An Integrated District Information System

The primary objective of the educational technology strategic plan is the establishment of an integrated information network that will link all the sites within the district and also link the district to remote points for information access and exchange. This plan focuses on each element of the District Information System and outlines the steps necessary to adopt and use modern information technologies in the district over the next five-year period.

This information system has two major components: an instructional component and a management/operations component. Each component consists of elements that can be arranged in a hierarchical pyramid with simple elements on the bottom and complex elements on the top. Technology, often relegated to the simple, "lower-order" functions in an organization (that is, data retrieval in management/operations and drill and practice in instruction) needs to be fully used in every level of both pyramids. When this occurs, technology will serve as a tool that maximizes the value of information to a school district and the students it serves.

The instructional portion of the information system provides a link between classrooms to a variety of curriculum enhancing resources available to the teacher. The second portion is the Management Information System, which provides management and operations information resources to teachers, administrators, and other site and district personnel.

A unique feature of the Integrated Information System is the ability to merge data. For example, classroom teachers may store grading information, while the office may input information on student test scores. Teachers working on curriculum development can analyze the current information on students' progress in a particular subject area. After determining student strengths and weaknesses, the teachers can draw more information from a curriculum alignment database that lists appropriate audiovisual materials. The teachers can then take the combined information and use it for the development of lesson plans appropriate to the needs of the students.

Elements of a Management Information System

A comprehensive Management Information System that would enable a school district to provide accurate and timely information to its users would include the following elements:

- adequate computer facilities to produce desired conditions
- a user assistance center
- an online Financial System, to include services for payroll, personnel and budget services.
- up-to-date student information and financial data available to all schools and district offices
- a District Communication and Support System consisting of word processing, electronic mail, desktop publishing, electronic calendaring, facility reservation, and district-personnel directory information
- a Student Information System that includes student test data, student transcripts, grading, student attendance, student scheduling, and historical records
- the Board policy online to the District Communication and Support System
- an integrated Business Information Manage ment System consisting of budget management, warehouse inventory and ordering, purchase request and monitoring, equipment inventory, and maintenance requests
- administrative Bulletins online to the District Communication and Support Systems
- specifications for the Student Instructional Management System that will include student IEP [instructional expectations and performance] goals and objectives, course outline/ objective bank indexed to IMC/S [instructional media center/services] inventory, computer managed instructional objectives
- an Instructional Materials Ordering, and Inventory System consisting of IMC/S
- inquiry, Ordering, and Library Functions
- training for staff in using above-mentioned desired systems
- a communications network that will not only service the district's telecommunications needs, but will also serve as the pathway for data communications and security and fire monitoring (Sacramento City Unified School District 1988)

Elements of the Instructional Information System

The Instructional Information System will provide teachers with the instructional tools needed to upgrade the quality and quantity of educational programs delivered to students. It will provide up-to-date information at a lower cost than current systems and will allow teachers to tailor educational programs to meet individual student learning modalities and needs.

The Instructional Information System is comprised of several elements. The "hub" of the instructional system is the District Communications Center. It is at this center that all instructional program resources are stored and controlled. At a user's request, information resources are downloaded from this center to an Information Resource Center located at each school site. The Information Resource Center at each site serves as the receiving point for information resources from the Communications Center and distributes these resources to the classrooms at the school site. The "end-users" of the information—the teachers and students at the school site—have access to the information resources at workstations located in each classroom. Finally, an administrative workstation is located at each school site to provide the site administrator with support services necessary to operate the school and to link the school with the district's overall Management Information System. A more detailed description of each element of the Instructional Information System follows.

District Communications Center

The District Communications Center is a facility designed to provide all the information needed for the K-12 instructional program. The center will serve as the "hub" as instructional information flows from site

to site within the the district. The function of the center is to distribute the information from the providers to the users. The center is designed to produce and distribute all instructional information resources.

Information Resources will include but not be limited to:

- Videotape, laser disk, CD-ROM, computer software, online data bases, and instructional programming
- Information—the storage and access to in structional information; the production of in structional television programming; the production of instructional units of study; the high speed distribution of information by most current systems, and direct assistance to all users
- Instructional products—the production, storing, and dissemination of manuals, teaching guides, learning packages, and staff development, incorporating modern information technologies
- Media—to provide for the previewing, distribution, and maintenance of all instructional media available to the school sites
- Professional library—to provide for the previewing, ordering, cataloging, distribution, and maintenance of all library services needed by school sites (Sacramento City Unified School District 1988)

School Information Resource Centers

The School Information Resource Center plays a critical role in an integrated instructional information system. The School Information Resource Center is the outgrowth of the continuing development of the school library. The role of the resource center has expanded from the collection of books and periodicals we once knew. In most school districts, the library has made the transition from its traditional roles to a center that deals with a much broader spectrum of materials. Such a center not only deals with books and periodicals, but also with audiovisual materials such as film, videotapes, computer software, laser discs, flat prints and models and displays, and electronic retrieval/delivery systems. The information center is an expansion of services that will serve the needs of students, parents, and staff.

A networked instructional and administrative system will enable all information relative to student instructional needs to be routed through the School Information Resource Center. As the role of the center expands, it will be necessary to add additional staff and provide inservice training to ensure that the systems function at an optimum level.

The Administrative Workstation

The administrative workstation, located in the administrative offices at each school site, provide a central system for the retrieval and use of both instructional and management information. This system will allow for electronic communication between school and district administrators, teachers, and the community. Through the use of this system, site administrators will be able to support the administrative operations of the local school, including classroom and school communication and data management. Some administrative uses of the systems might include student demographics, office automation applications, guidance and scheduling, testing achievement, monitoring of lesson plans, and so forth.

The Teacher Workstation

The teacher workstation will be able to send and retrieve information from both the instructional and management information systems. Here, the teacher can input, access, store, retrieve, and use data; use electronic communications; and have remote access to video and instructional programs. Making use of the instructional information system allows the teacher to control instructional software used by the student. By monitoring student workstations, and through record keeping programs, the teacher can analyze student progress.

Access to the management information system provides teachers with timely information regarding student demographics, allowing quick intervention strategies for at-risk students. A link with the districtwide area network enables the teacher to send a variety of information to the Information Resource Center, the school administrative offices, and, if appropriate, the Information Services and Educational Technology Department.

The Student Workstation

The student workstation is designed to provide students with access to information and programs that will enhance the instructional process. From here, the student can make use of information resources and instructional activities as a part of the classroom program. While at the teacher workstation, the teacher will present lessons designed for large group instruction. The student workstation is primarily designed for individual and small-group instruction.

Although student workstations will be fully networked to allow for maximum use, the actual configuration of the workstations will be determined by student/teacher need, grade level, and curriculum.

The Classroom of the Future

Tomorrow's Classroom Today is the name for an extremely constructive concept that is operative at the Sacramento district. As part of a concerted effort to examine the integration of modern information technologies into instruction and administration, the SCUSD has established a model classroom that is being used for researching, developing, testing, educating, evaluating, and training for new computer software and hardware systems. The development of this facility came from the concept that technology does play a major role in the teaching/learning process as well as in classroom and school management.

The idea was to form a partnership of business, industry, and the school district to share resources for enhancing the educational process and preparing educators and students alike for the world of the future. These resources have their focus in this unique research and development installation that is operating at the very growing edge of educational technology. The work that is being done at this demonstration site may permanently change the architecture of instructional design and the processes of educational management.

In the Tomorrow's Classroom Today development laboratory, one of the major objectives is the development of a prototype for the next generation of teaching stations. The design may well serve as a model for the rest of the nation's schools as educators attempt to provide students with the resources they need to succeed. Every kind of developing technology applicable to education is being integrated here with the principal intent of advancing teaching methodology. Whereas technology has fulfilled all its promises in terms of potential applications, education has not so far kept pace. At this experimental site, however, the potentials of that technology are being tapped in response to the need for improving education and raising the level of teaching and learning excellence.

The demonstration site is a converted classroom in one of the elementary schools of the district. This classroom contains an array of information technologies—including video, communication, and computer systems—all controlled through a teacher workstation. Through the results of the work of educators using these cutting-edge systems, the district can identify not only a preferable future, but also clarify the critical issue of priority allocation of scarce resources and establish criteria for standardization of systems.

Upon entering the room, one is struck with the low background noise level and the uncluttered appearance. Sound-absorbing, antistatic carpet covers the floor and extends part way up the walls. Regular acoustic tile lines the ceiling. Around three sides of the room is a continuous bench on which rest the microcomputers of all the leading manufacturers connected in a single functioning network! (This open architecture will allow any brand of hardware to be purchased.) None of the connecting wires are visible. They are all hidden in a continuous covered trough built where the old chalk trays used to be.

In the center of the floor area are a number of tablet arm chairs that can be clustered together or turned to face the front of the room. There, in place of the standard chalkboard, movie screen, tracks, and roll maps, is a large, projection-type TV console and a nearby teacher-controlled station. This main station consists of a control panel, various kinds of media-handling equipment, and a computer keyboard and monitor. The control panel allows the output from the various pieces of equipment to be directed to the TV console or the student workstations. The equipment includes a laser disc player, a VCR, and a video camera mounted in place of an overhead projector. This control center is mounted on a low platform that provides access to the wiring that converges here from other parts of the room and with the cables that will eventually connect into the district network and media centers. The connections will also provide communication capabilities with distant information bases and live video-conferencing capabilities.

The design and functioning of this installation is mainly owing to the technological wizardry of Kerry Johnson, director, Information Services and Educational Technology. Among his many abilities is that of being able to design and manage local area networks, a key capability for any organization that contemplates the establishment of a functional information system.

Superintendent Larick emphasizes that this is a demonstration site and not a working classroom. It is intended for research and development and as a training center where people can "stretch their heads about what schools could be like." Larick outlines several concepts that are implicit in the operation of this center:

1. The central idea was to form a coalition among hardware manufacturers and software developers so that they could begin working with educators for their mutual benefit. For the first time, vendors were able to display their hard-

ware *networked* together in one place with much to be learned about educational applications and requirements.

2. It is a place to try to determine what the future "teacher's desk" would look like and what would be available to them: all the technologies integrated into one operating system providing remote control of any technology at any place in the room.
3. The installation provides a center for the testing and validation of beta software projects with major developers such as IBM.
4. The facilities provide the means to train instructional leaders in the design processes necessary to integrate educational technologyinto teaching methodology and the curriculum. (Sacramento City Unified School District 1988)

Carol Bly, coordinator of technology and staff development, also takes an active role in the operation of the center. Among her activities are conducting training and demonstration exercises for both certificated and classified personnel. The training consists of explaining the workings of the various technologies in conjunction with demonstrations, and also having practitioners touch and use the system. She emphasizes the critical importance of having classified personnel who assume major responsibility for many district operations outside the classroom gain an overall picture of what is going on and of learning where their work fits into the organizational scheme.

Model Technology Schools

The Tomorrow's Classroom Today concept is the key element in a broader Model Technology Schools project. This is a pilot program in which the concepts developed at the research installation are carried over and applied in actual working classrooms in several schools throughout the district. The eventual plan is to convert library-media centers into full information centers that will become part of a district information system connecting approximately one hundred sites. One of the goals is to create a computerized catalog of all hardback books and other media indexed as to the information contained. This will make it possible for teachers to order electronically the information or materials they will need the following day. During the night, the required information will be stored in the host computer where it can then be accessed by the teacher for use in teaching. Problems of sharing limited resources among large groups of students and the time involved in searching and doing actual legwork are largely eliminated.

While many school leaders will retire in the next decade, those who remain will have to make tremendous accommodations in their traditional management and leadership methods. Similarly, the role of teachers is going to change in important ways, with much more emphasis being placed on management and coordination of instruction combined with a thorough knowledge of instructional design skills. Evaluation will be built into the system. Educators will have to accept much more responsibility and a higher level of accountability for instructional outcomes. Professionalism will gain in the process. Policy-makers will also have to be much more explicit about the goals of education in order to provide the necessary guidelines for administrative policy under which education procedures and strategies will become operative.

It is appropriate to remind ourselves at this point of the ultimate purposes of technology integration in the educational program of the schools.

Technology Integration in Curriculum

Integrating technology in the curriculum goes beyond an add-on approach to the existing curriculum. Perelman, in *Technology and Transformation of Schools* (1987), sets the frame of reference:

> "Education" *is* the "technology" of education—productive innovation in any component almost invariably requires modification of the entire system. The common practice of trying to simply *add-on* technology to education while actively prohibiting transformation of the rest of the system's social infrastructure is just what has made much of the technological experimentation in education fruitless. (p. 33)

The aim of the educational technology plan is first and foremost to be a resource for enriching education. It is not a substitute for teachers, but a resource to help teachers work in the most effective and stimulating way possible. The integration of technology in the instructional process will provide both the teacher and students with additional tools that will assist both with "maintenance" as well as "innovative" learning. According to the education technology strategic plan, the effective integration of technology will:

- Make curriculum content more immediate and relevant as a result of the ability to electronically access such resources as dynamic databases and electronic communication systems. Through skills learned, students will be more able to function in an information society. To maintain contemporary standards, schools will

be able to more rapidly update their existing courseware through simple replacements of storage devices such as CD-ROMs.

- Address varied learning modalities by making use of a wide spectrum of media. The increased use of a blending of video, computer, and communication systems will provide teachers with more options for addressing these modalities through both the presentation and delivery of instruction.
- Provide the teachers with a potential for a more individualized approach that is more efficiently monitored and adjusted to meet learner needs.
- Make education more accessible for students with special needs such as visual or hearing impairments, learning disabilities, multilingual, and so forth.
- Move the curriculum beyond being content focused to that of also including process strategies that will encourage the development of higher order/critical thinking strategies.
- Provide for the expansion and growth of skills that will promote better performance on district and state tests. (Scaramento City Unified School District 1988)

Work being done in Tommorow's Classroom Today is modeling traditional curriculum development with the inclusion of the potential uses of the system. In addition, modeling the appropriate uses of technology provides teachers with a base from which they can begin to develop their own uses of the systems and strategies. Empowering teachers with appropriate access to systems and strategies for enhancing their instructional program will result in the empowerment of students with life-long learning skills as they become more intimately involved in their own instruction.

The trend is clear. To enable students to become fully functional citizens in an information-based society, the issues of information and technology must be addressed today. Decisions concerning the selection of hardware and software, the allocation of economic and human resources, the revision of organizational structure, and the improvement of curriculum and instructional strategies must be made today. The strategic planning process has been developed to provide the basis for these and other technology-related decisions.

A Look Back and a Look Ahead

In this paper, I have presented an analysis of the growing impetus for change in public education. Through cultural and technological evolution, society's needs, goals, and resources change. With different inputs and revised goals, the operations that take place within the schools must change accordingly.

Major revisions in organizational structure and function are needed to achieve the levels of operational efficiency and effectiveness necessary to meet the challenge of increasing social complexity and increased risk. The bureaucratic structure presently endemic in education resists change. Leaders and policy-makers should move instead toward adopting an open-system perspective for educational organizations that emphasizes the contingency relationship with the external environment.

The correlate administrative concept is that variable environmental demands require variable organizational responses. This kind of adaptability can be gained through a management information system that is used to gather precise information that links external environmental needs with internal structures.

The operational framework presented here will gain credibility as a problem-solving model as more administrators come to recognize its value in identifying the parameters of change and begin using them to aid in strategic planning and organizational development. Six major systems were identified that comprise the contextual and operational environments of an organization: setting, resources, governance, implementation, process evaluation, and integration. A number of subsystems and functions were also defined in a way that helps affirm their critical importance in organizational design and creates an awareness of the need to closely monitor the dynamics of the system setting and operations. Several of the most important ideas to emerge from the action research are these:

1. The concept of environmental scanning derives from the need to thoroughly understand the organizational setting, including the conditions and purposes for change and the internal and external environmental determinants that limit or force change.
2. Rational decisions are ineffective unless made in conjunction with an explicit value system.
3. Due to technological innovation and cultural evolution, teaching methodology and curricu lum content will remain in flux; therefore, strategies for coping with continuous change must be developed.
4. There is a pressing need to revise educational structure particularly in terms of leadership, incentives, and goal consensus expressed through public policy.
5. The finding that most teachers become preoccupied at the mechanical level of use when adopting a new technology leads to the belief that the implementation plan that will work is one that focuses on teachers first: install a system where teachers cannot do their job without using the technology, then fully support them with resources and training.
6. One way to motivate teachers is to help them overcome the feelings of powerlessness in the face of growing societal demands. This will happen if teachers gain technological control that allows them to greatly increase instructional effectiveness.
7. Parity for all students requires major organizational, curricular, and methodological changes in all grades in conjunction with substantial expenditures for facilities, renovation, equipment, materials, maintenance, and support services.
8. Educational goals and standards of accomplishment are not negotiable. They define the purposes of the educational system.
9. Policy-making consists of decisions and commitments that direct administrative action. Policy defines the *what* of the system. Implementation consists of decisions made about strategies that represent the means for gaining desired ends. Process action defines the *how* of the system.
10. Administration in essence is leadership of the decision-making cycle associated with development and management of intervention and transformation procedures.

11. Contingency management rests on the existence of a communication structure within an organization that provides the necessary inputs for decision-making.

12. Preservice training of teachers should concentrate on improving technological literacy through (1) presentation of theory, (2) modeling of skills, (3) providing practice in simulated and classroom settings, (4) using structured and open-ended feedback about performance, and (5) coaching in the transfer of skills and strategies to the teaching environment. A pronounced weakness in instructional design skills is held to be responsible for the lack of exploitation of the educational potential of the microcomputer.

The case study of the Sacramento City Unified School District indicates that where the elements of the problem-solving model are incorporated into the process of change and innovation, districts can make substantive changes in the system and incorporate technological innovations. It is quite clear that for public schools to succeed today and tomorrow, that the strategic planning process is an imperative for school system.

There is some sense of urgency for these changes as expressed by Sacramento City Superintendent Keith Larick, in a presentation at the IBM Educational Systems National Executive Conference in Atlanta:

> When an economy is knowledge based, learning becomes the strategic industry. The educational system is at a crossroad. A business-as-usual approach to education policy or to reform will lead to an educational system that has failed and an economy without value. An alternative to this is a commitment to restructuring the basic technology and organization of education.
>
> If we as leaders are to reinvent education, we must first have developed a mental image of a possible and desirable future. This process requires us to engage in some form of strategic planning. The process allows leaders to think and plan in terms of what is possible, what is probable, and what is preferable.
>
> This method of planning or doing things says that you are responsible and accountable today—for tomorrow. You have a measurable degree of control over your destiny by the decisions and actions you take today. (Unpublished notes of presentation, August 1988)

Infusion of technology into the instructional, management, and operations of schools is the immediate challenge. But, change and innovation that proactively anticipates and plans for the future is the lasting challenge confronting schools today. We will, in the final analysis, be measured tomorrow for our vision and actions today.

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